More grain, with sustainable gain

Barley serves as a major feed crop, especially in climate areas like Norway and the northern United States. In an effort to develop feeds for the future, a cooperative research program was established between the USDA/ARS Trout-Grains project (Hagerman, Idaho) and the Aquaculture Protein Centre in Norway to increase the potential of barley as a novel ingredient for aquafeed. Although barley has a favourable amino acid profile, it is low in protein; therefore, the focus of this project is on **barley protein concentrate** (55% protein). The primary goal of this long-term project is to explore the interaction between organic acids and extruder temperatures on the nutrient availability of barley.

The extent to which organic acids increase barley's digestibility is of particular interest to APC's doctoral student Thea Morken (photo, right). Thea is investigating the effects of **processing aids** and **extruder temperature** on the digestibility of plant-based fish feed. Currently, she is measuring the effects of hydrothermal treatment on the digestibility of barley. Thea hypothesizes that *adding processing aids to diets may prevent heat-induced damage to protein during hydrothermal feed processing.*

Professor Margareth Øverland (and APC Centre director) researched the potential of barley feed whilst studying at Montana State University (1983-1988), and arranged Thea's summer project with Dr. Rick Barrows (above photo, left) at the Feed and Nutrition Laboratory in Bozeman, Montana. Whilst Thea conducted a series of barley feed trials with trout, with the assistance of APC's Dr. Olav Fjeld Kraugerud (below photo, right), Margareth planned further collaboration between APC and the USDA.

The partnership makes sense. Both organizations have initiated research programs to increase the use of plant proteins, both complement each other: Idaho produces more than half of US farmed trout; Norway produces more than a million tonnes of aquafeed. From a research perspective, USDA-Hagerman is instrumental in grain development and processing research; APC pioneers novel feeds and explores methods to optimize protein value, eliminate anti-nutritional factors, and reduce disease susceptibility. Working together, their synergy will advance the potential of this alternative protein source by understanding the interaction between processing and nutrition.

Barley at its best

Fish feed is mainly produced by extrusion technology, where the feed is extruded at high temperatures and then dried. Thea balances the uncertainty between heat-processing and nutrition: "On the one hand, extrusion improves protein digestibility by degrading heat labile anti-nutrients, such as protease inhibitors and increases energy from carbohydrates. On the other hand, high temperatures might reduce protein digestibility."

In an effort to better understand the interaction between extrusion and nutrition availability, Thea and Olav assisted Rick Barrows in two experiments testing the palatability and digestibility of barley-based diets, with or without a processing aid. The pellets were extruded at three temperatures, 110°C, 125°C, and 140°C, yielding 10 different treatments.

In addition to the USDA's expertise with barley and Rick's experience with trout, another advantage was Bozeman's facilities, which included a small-scale extruder. "Unlike an industrial extruder, where you need five tons of feed to make trial pellets," says Olav, "at the Fish Technology Center all you need is 30 kilos."

Margareth was as impressed with USDA facilities as she was with Montana's landscape (below photo, center): "The experiment required 30 tanks and 600 trout. Although it's too early to evaluate the results, the future looks promising. Looking toward the future, APC and the USDA will continue working together, pioneering feeds for the future."